Real-time Operating Systems and Systems Programming

Scheduling
Lecture 8

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Classical scheduling

- Two goals:
  - Maximize processor usage
  - Minimize response time of tasks
- Evaluation:
  - Task waiting time
  - Processor throughput
  - Total execution time of tasks
  - Average response time of tasks

Scheduling decisions

- Preemptive or non-preemptive
- Static or Dynamic
- Soft or Hard (Best effort vs Strict)

Scheduling strategies

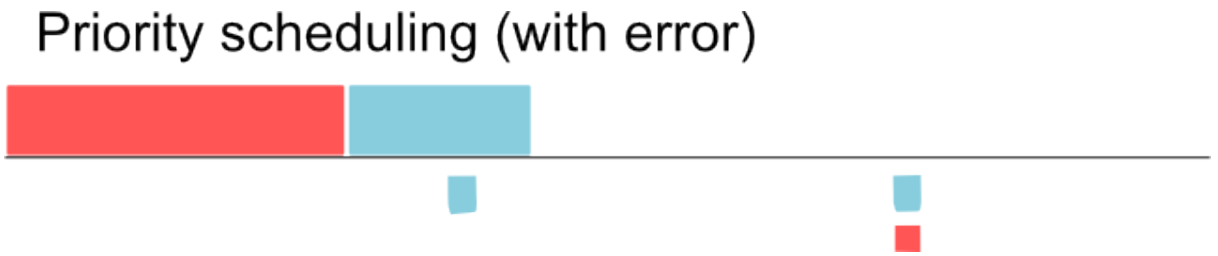
- Round-robin
- First come first served (FIFO queue)
- Prioritized scheduling
- Deadline prioritization
- Shortest first

Implementation details

- Election table
- Priority queue list
- For complex scheduling, *two level* scheduling can be implemented
  - High level decisions on general policy that affect longer periods
  - Lower level scheduler decides reordering for immediate future

Prioirity scheduling

- Red is of higher priority, but with longer deadline

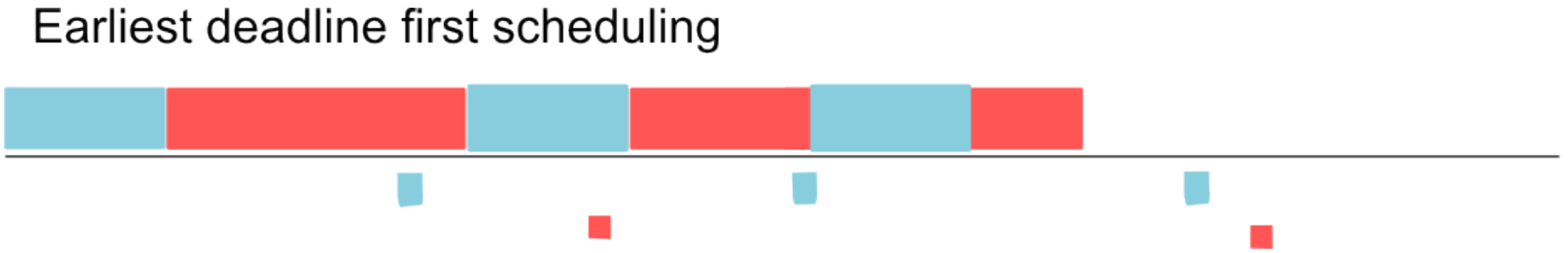


Rate monotonic scheduling

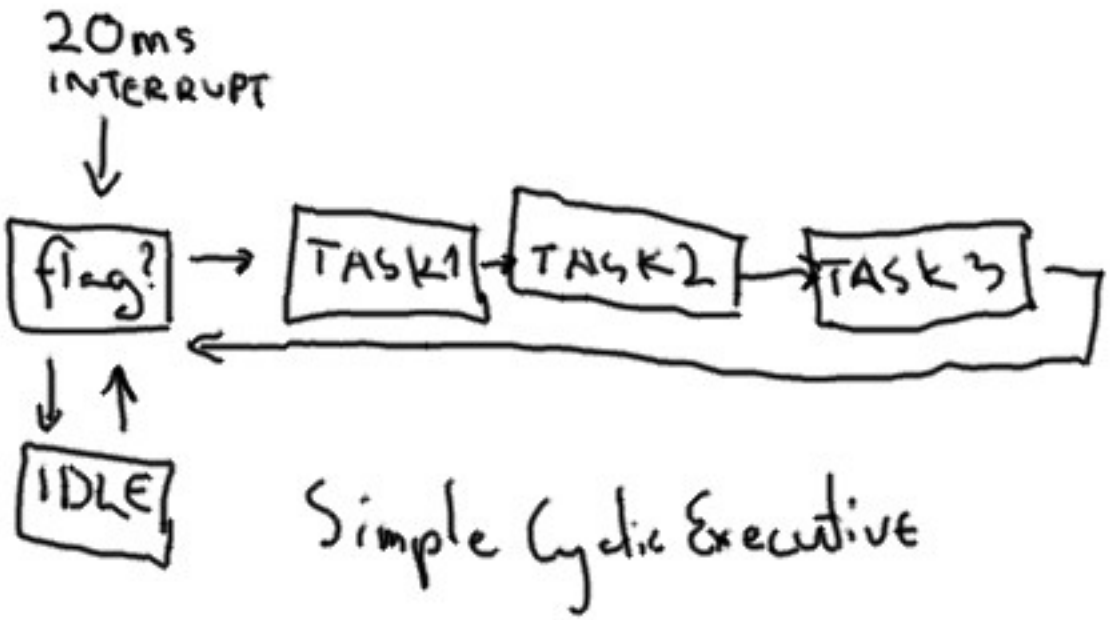
- Priority is inverse of the period
  - Short periods are high priority and vice versa

Earliest deadline first

- Priorities are assigned according to deadlines



Cyclic Executive



Cyclic Executive

- Offers 3 priorities for tasks
- Interrupt if pre-emption is needed (high priority)
- HW Clock with cooperative scheduling (middle priority)
- Base code with first come first served priority (low priority)
- Inflexible, since does not offer task “aging” or dynamic scheduling
- Simple to test

Tasks exeeding time-slot

- Might be possible to split larger tasks.
- Starts on even ticks, then yields time to others
- Finishes on odd ticks

Idle

- Idle task could be replaced with low-priority things
- Also called Burn

Posix scheduling

- Phtread scheduling with function:
  - sched_setscheduler()
  - SCHED_FIFO – realtime
  - SCHED_RR – realtime with timeslots
  - SCHED_OTHER – normal scheduling
  - SCHED_BATCH – less prioritized normal (Linux 2.6.16+)
  - SCHED_IDLE – lowest possible priority (Linux 2.6.23+)

SCHED_FIFO

- FIFO processes pre-empt any OTHER and BATCH processes.
- If FIFO process is pre-empted it wil resume as soon as higher-priority processes are blocked
- If becomes runnable, inserted to queue
- sched_setscheduler() puts in front of queue if runnable (ignoring POSIX)
- sched_yield() to send self to end of list

SCHED_RR

- Round Robin enchances FIFO
- Each process gets maximum time quantum
- If runs longer, put to end of queue
- sched_rr_get_interval() will return the quantum

SCHED_OTHER

- Normal way of things
- Processes run according to the nice value
  - nice() or setpriority() used to set the value
- The priority increases each quantum processes are ready, but denied time
- SCHED_BATCH assumes CPU-intensive process which is not interactive and it gets a penalty in priority

Permissions

- CAP_SYS_NICE permission needed
- Unprivileged processes can set SCHED_OTHER for the same user
- Can be overriden
- Processes running under SCHED_IDLE cannot change to something other without permissions

Miscellaneous

- Child processes inherit their parents' scheduling policy
- Real-time processes need memory locking (mlock() and munlock()) to avoid paging delays
- A non-blocking loop in _FIFO or _RR priority will lock the computer unless a shell is scheduled on same level prior to running it for killing it off. Remember when debugging.